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ABSTRACT

Although the enrollment of minority freshmen in engineering has increased substantially during the last two decades, attrition has remained intractable. This document analyzes comparative data on the performance of institutions in retaining minority students through graduation. The objective of this effort was to identify characteristics of the most successful engineering schools and to explore the implications of those characteristics for all institutions. Two measures of retention are considered: the minority graduation rate and minority graduation rate relative to the nonminority graduation rate. These measures are then compared with institutional control, college cost, selectivity, number of engineering programs, and number of student support programs offered. Analysis indicated that the colleges and universities that have been most effective in graduating a significant percentage of their minority freshmen are the same institutions that enroll minorities as an extremely small fraction of each year's entering class. An analysis of the variables most highly correlated with retention suggested a distinct institutional climate conducive to minority retention. Three interrelated factors--high selectivity, private control, and high college cost--were most strongly associated with institutional success in retaining minority engineering students. (JRH)

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ED 401 109

Retention of Minority Students in Enginering: Institutional Variability and Success

by
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NACME

Research Letter

Retention of Minority Students in Engineering

Institutional Variability and Success

Catherine Morrison, Kenneth Griffin and Peter Marcotullio

Highlights

- The average graduation rate of underrepresented minority students for the three freshman classes that entered a sample of 112 institutions between 1986 and 1989 was 35.0 percent. This is virtually unchanged from the national average for students graduating in the 1980s, based on an earlier NACME study of a similar sample of institutions. Since that time, however, the graduation rate of nonminority students declined 9.1 percentage points to 59.3 percent.
- More than half of all minority graduates came from 36 engineering schools. Only five institutions produced more than 100 minority graduates, and an additional 17 produced more than 50. Of these 22 schools, five were HBCUs and five were HACUs.
- Half of the nation's engineering schools (169) graduated fewer than six minority students per year.
- A total of 58 schools produced no minority graduates between 1991 and 1993.
- In an expanded sample of 162 schools, public institutions enrolled and graduated significantly more minority freshmen than private institutions; however, private engineering schools graduated a much greater percentage of the minority students they enrolled (60.5 percent) than public institutions (38.5 percent). This may be attributable to aggresive recruitment of students with inadequate financial resources and/or inappropriate precollege preparation.
- Among a variety of institutional attributes examined, selectivity was the most important predictor of degree attainment for both minority and nonminority engineering students.
- Typically, we found the more expensive the institution, the higher the gradua-

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Although the enrollment of minority freshmen in engineering schools has increased more than six fold during the last two decades, attrition has remained intractable. Excessive for all engineering students, it is disproportionately high among African Americans, Latinos and American Indians, groups long underrepresented in engineering and other science-based fields. Over the past ten years, while almost 45,000 minority students earned bachelor's degrees in engineering, more than 75,000 dropped out. Given that only six percent of the nation's minority high school students graduate with the academic prerequisites to enroll in an undergraduate engineering program, their loss, this far along in the pipeline, represents a major forfeiture of the nation's human resources.

Since 1981, NACME has developed and analyzed comparative data on the performance of institutions in retaining minority students through graduation. Our premise in providing this information is that retention and relative retention are useful measures for comparing institutional performance and for accountability, even where universities have widely differing missions and objectives. By identifying the institutional and educational factors common to those schools most successful with minority populations, NACME's goal is to eliminate institutional barriers to success and to offer recommendations to improve minority retention in engineering programs nationwide.

Introduction

The performance of institutions in the education of minority engineers for the nation's workforce can be compared by examining two parameters: access, as demonstrated by the total number of minority graduates produced each year, and retention, the fraction of full time entering freshmen who obtain a degree in engineering within five years of enrollment. Because increased retention presents the greatest short term opportunity to significantly increase the production of minority engineers, NACME's objective in conducting this study was to identify characteristics of the most successful engineering schools — those having the highest retention and relative retention of minority students — and to explore the implications of those characteristics for all institutions.

In considering the two aspects of institutional performance, access and retention, we looked at two measures of retention: the minority graduation rate, and minority graduation rate relative to the nonminority graduation rate, which NACME terms the Relative Retention Index (RRI). Based on the average number of engineering graduates produced by each institution

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Highlights
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tion rate for all students. Furthermore, the relative retention index (the ratio of minority to nonminority graduation rates) was greater at high-cost colleges (93.2 percent) than at low-cost (66.9 percent) and medium-cost schools (65.9 percent).

- After statistically controlling for selectivity and institutional control, higher costs predicted lower relative retention.
- Interviews with administrators at the most successful institutions suggest other factors that impact degree attainment: (1) strong institutional commitment as evidenced by attitudes of faculty and staff, integral minority engineering programs, and allocation of resources; (2) focus on removing barriers to student success; (3) involvement of the corporate community; (4) precollege development of potential engineering students; (5) summer bridge programs; and (6) special attention to early success of freshmen.
- Exemplary schools attribute their success to idiosyncratic programs outside the rubric of traditional support programs. These institutions looked inward to analyze and better understand their own culture, to focus on their undergraduate education mission, and to develop specific adaptations to make their institutions more effective with all students.
- To compete with other institutions for scarce resources, the predominantly minority-serving schools at which we conducted interviews (i.e., those that are most successful) are aggressively recruiting students with conventionally strong academic backgrounds. This signals a shift away from the traditional focus on broad access for able students who may not have had earlier opportunities to develop their academic potential.

from 1990-91 through 1992-93, this study repeats a NACME analysis of institutional performance during the decade of the 1980s, allowing us to compare trends over time. The minority graduation rate and RRI are then compared with five characteristics of the engineering schools: institutional control (public vs. private), college cost, selectivity, number of engineering programs, and number of student support programs offered. In addition, we looked at the aggregate performance of two sets of institutions that play a unique role in educating engineers, research institutions and schools whose mission explicitly includes serving the African American and Latino communities, i.e., the Historically Black Colleges and Universities (HBCUs) and members of the Hispanic Association of Colleges and Universities (HACUs).

To illuminate the statistical findings, we conducted interviews with deans of engineering or their representatives at a sample of eight institutions that have a record of success in graduating minority engineers.

Access: Number of Minority Graduates

During the years covered by the study, the annual number of minority graduates in engineering, nationally, increased almost 12 percent, growing from 4,575 in 1990-91 to 5,122 in 1992-93. Despite this overall growth, the performance distribution of individual engineering schools remained much as it was during the 1980s, highly skewed, with a relatively small number of colleges and universities producing the bulk of the minority graduates (Figure 1). Examining the average number of minority graduates produced annually by all 338 schools reporting data, which is collected by the Engineering Workforce Commission under a NACME grant, we found:

- More than half of all minority graduates came from only 36 engineering schools;
- Only five institutions produced more than 100 minority graduates, and an additional 17 produced more than 50. Of these 22 schools, ten were HBCUs or HACUs;
- Half of the nation's engineering schools (169) graduated fewer than six minority students per year;
- A total of 58 schools produced no minority graduates between 1991 and 1993. This is an increase of nine since the study of the 1980s. In the earlier study, which covered a longer period, there were 49 institutions producing no minority graduates.

Table 1 ranks all 338 engineering schools by the average total number of minority engineering graduates produced from 1990 through 1993.

National Graduation Rates

Before calculating national and comparative graduation rates (see *Computing the Graduation Rate*, page 3), we minimized potential distortions by filtering out schools with incomplete data, schools where students don't declare a major until the end of the freshman or sophomore year, and schools where results may be skewed by an influx of transfer students, as evidenced by greater than 15 percent average increases in enrollment from freshman-to-sophomore years. To assure that the institutions studied had sufficient minority populations to allow an assessment of relative performance, we applied an additional filter eliminating schools with fewer than ten minority students in the freshman classes for the years 1986 to 1989. One hundred twelve institutions met all criteria for inclusion. These institutions produced about 54 percent of all minority engineering graduates from 1991 to 1993.

To correct for anomalies in any given cohort, we compared the number of freshman engineering students in three consecutive entering classes (1986-87 through 1988-89) with the number of graduates in the corresponding classes five years later (1990-91 through 1992-93). Based on national enrollment and graduation data averaged for these three academic cohorts, we found:

- The graduation rate for minorities at institutions meeting the criteria for inclusion remained almost static since

Figure 1.
Distribution of Minority Graduates

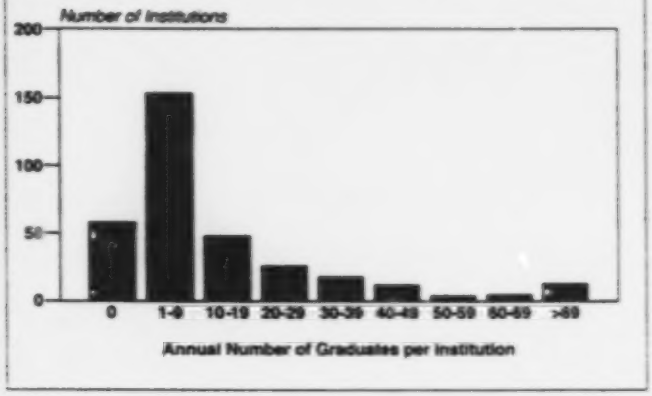
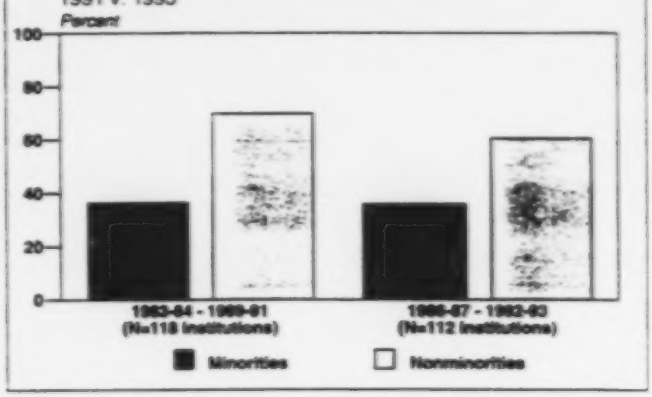


Figure 2.
National Engineering Graduation Rates
1991 v. 1993



the 1980s when compared to a similar sample of institutions, falling slightly from 35.6 to 35.0 percent (see Figure 2).

- Again comparing the samples from both time periods, nonminority graduation rates declined sharply, dropping from 68.4 to 59.3 percent.

The resulting growth in relative retention of minority students, from an RRI of 52.0 percent in the 1980s to a current RRI of 59.1 percent, is primarily a function of declining nonminority retention, rather than evidence of institutional progress with minority students. In interpreting the national data, however, it's important to note that the sample of 112 institutions purposefully excludes those schools serving an almost exclusively nonminority population. While this affords the opportunity to measure relative retention, it also makes the nonminority results somewhat less generalizable to the total set of institutions.

Interestingly, the period during which these changes occurred was characterized by high growth in the enrollment of minority students and significant declines in the enrollment of nonminorities.

Institutional Graduation Rates

To assess the performance of individual engineering schools in the sample, we developed an average graduation rate for minority students at each institution, assuming that a five-year time-to-degree is typical. The three-year average of freshman classes entering between 1986 and 1989 was compared to the three-year average number of minority graduates five years later. This ratio, called the minority graduation rate, presents a picture of an institution's actual versus potential yield. Table 2 presents these data for each institution, listed alphabetically, and Table 3, in rank order by minority graduation rate.

A second perspective on performance was developed by comparing the success of individual institutions in graduating minority students relative to the graduation of nonminority students. After establishing a nonminority graduation rate for each school in the sample, we calculated its Relative Retention

Computing the Graduation Rate

To compute aggregate national graduation rates for minorities and nonminorities during the years of the study, we compared the total freshman enrollments from the cohort years 1986-87 through 1988-89 with the total number of graduates from 1990-91 through 1992-93. This technique smooths out anomalies associated with variations in the amount of time different students take to graduate and doesn't filter out students who transfer, but complete an engineering degree.

In the individual school calculations, the graduation rate is sensitive to the influx of transfer students. Schools that acquire engineering majors after a first cohort year may have an overstated freshman graduation rate. The exceptions are those schools, i.e., Massachusetts Institute of Technology, where freshmen do not claim majors. We therefore filtered out institutions with inflated rates by first examining changes in total enrollment between the freshman and sophomore classes and then comparing specific transfers by group category from freshman to sophomore year. A 15 percent increase in total number of students or a 15 percent increase in a group of students (minority or nonminority) were the criteria for excluding schools. Also schools with fewer than ten minority students enrolled were dropped from the analysis.

For the resulting sample of 112 schools, the national minority graduation rate was 35.0 percent and the nonminority graduation rate was 59.3 percent. Based on these calculations, the Relative Retention Index (RRI), which compares the rate of retention of minority students with nonminority students, was 59.1 percent. In computing graduation rates, only schools with complete enrollment and graduation data were included.

Table 1.

Engineering Institutions* Ranked by Average Number of Minority Graduates (1991-93)

Rank	Institution	Average Minority Graduating Class (1991-93)
1	North Carolina A&T State University	130
2	Georgia Institute of Technology	120
3	Howard University	109
4	Florida International University	102
5	Prairie View A&M University	101
6	Mass Institute of Technology	99
6	Texas A&M University	99
8	Tuskegee University	94
9	CCNY (City College, CUNY)	92
10	U Texas-Austin	83
10	U Texas-El Paso	83
12	North Carolina State U-Raleigh	79
13	California State U-Long Beach	70
14	Southern University	68
14	U Florida	68
16	New Mexico State University	61
17	New Jersey Institute of Technology	60
17	California Polytechnic-Pomona	60
19	California Polytechnic-San Luis Obispo	58
20	U California-Berkeley	57
21	Stanford University	55
22	Purdue University	53
23	U Illinois-Urbana Champagne	49
23	Pratt Institute	49
25	U Maryland-College Park	47
26	Texas A&I University	46
27	U Michigan-Ann Arbor	44
27	Rensselaer Polytechnic Institute	44
29	U New Mexico	43
30	FAMU/FSU College of Engineering	42
30	US Military Academy	42
32	California State U-Northridge	41
33	U South Florida	40
33	U Miami	40
35	NY Institute of Technology	39
36	U California-Los Angeles	38
36	Cornell University	38
36	U Arizona	38
39	San Jose State University	37
39	US Air Force Academy	37
39	Tennessee State University	37
42	U California-Davis	36
42	Michigan State University	36
44	Polytechnic University	35
44	California State U-Sacramento	35
46	U Illinois-Chicago	34
46	U Washington	34
46	San Diego State University	34
49	US Naval Academy	31
49	Morgan State University	31
49	Clemson University	31
52	Florida Atlantic University	30
53	California State U-Los Angeles	29
54	Virginia Polytechnic Institute	28
54	Mississippi State University	28
54	Penn State University	28
57	U Alabama	27
57	Northwestern University	27
57	Rutgers University	27
60	U Texas-San Antonio	26
61	Ohio State University	25
62	Drexel University	24
63	GMI Engineering & Management Institute	23
63	Illinois Institute of Technology	23
63	U Southern California	23
63	Auburn University	23
67	U Virginia	22
67	Florida Institute of Technology	22
69	Louisiana State University	21
69	Stevens Institute of Technology	21
69	U Cal-San Diego	21
69	Boston University	21
73	U Tennessee-Knoxville	20
73	U Delaware	20
73	U Colorado-Boulder	20
73	California State U-Fresno	20
73	U Central Florida	20
73	U Texas-Arlington	20
79	U Houston	19
79	Arizona State University	19
79	U District of Columbia	19
82	Northeastern University	18
82	Princeton University	18
82	Columbia University	18
82	U Pennsylvania	18
86	U California-Santa Barbara	17
87	U Missouri-Rolla	16
87	Lawrence Technological University	16
87	U Oklahoma	16
90	U Massachusetts-Amherst	15
90	Lamar University	15
92	Tulane University	14
92	SUNY-Buffalo Campus	14
92	U Pittsburgh	14
95	Texas Tech University	13
95	U California-Irvine	13
95	Colorado School of Mining	13
95	Manhattan College	13
95	California State U-Fullerton	13
95	U Rhode Island	13
95	Vanderbilt University	13
95	U Missouri-Columbia	13
95	Case Western Reserve University	13
95	U Arkansas	13
105	Memphis State University	12
105	Hampton University	12
105	Duke University	12
105	Washington University	12
105	Rice University	12
110	U South Carolina	11
110	SUNY-Stony Brook	11
110	U Wisconsin-Madison	11
110	Syracuse University	11
110	Washington State University	11
110	Wayne State University	11
110	U New Orleans	11
110	U Louisville	11
110	San Francisco State University	11
110	Clarkson University	11
110	Old Dominion University	11
121	U Dayton	10
121	Santa Clara University	10
121	U Notre Dame	10
121	Marquette University	10
121	U Alabama-Huntsville	10
121	Colorado State University	10
127	George Mason University	9
127	Oklahoma State University	9
127	U Minnesota	9
127	Mercer University	9
127	Iowa State University	9
127	U Cincinnati	9
127	Johns Hopkins University	9
127	Cleveland State University	9
127	Lehigh University	9
127	Christian Brothers University	9
127	Southern Illinois U-Edwardsville	9
138	Michigan Tech University	8
138	Loyola Marymount University	8
138	Kansas State University	8
138	Parks College-St Louis	8
138	U Colorado-Denver	8
138	Temple University	8
144	Embry Riddle Aeronautical University	7
144	U Kansas	7
144	Worcester Polytechnic Institute	7
144	U Michigan-Dearborn	7
144	Norfolk State University	7
144	Ohio University	7
144	U Alabama-Birmingham	7
151	Widener University	6
151	George Washington University	6
151	Brown University	6
151	U Rochester	6
151	Tufts University	6
151	California State U-Chico	6
151	Oakland University	6
151	U Detroit	6
151	Carnegie Mellon University	6
151	Northrop University	6
151	Brigham Young University	6
151	Southern Illinois U-Carbondale	6
151	Cooper Union	6
151	Harvard University	6
165	Northern Arizona University	5
165	Purdue U-Calumet	5
165	New Mexico Institute of Mining & Technology	5
165	West Virginia University	5
165	Milwaukee School of Engineering	5
165	U Texas-Dallas	5
165	St Marys University	5
165	Fairleigh Dickinson University	5
165	Southern Methodist University	5
165	Rochester Institute of Technology	5

Rank	Institution	Average Minority Graduating Class (1991-93)
165	U Pacific	5
165	U Connecticut	5
165	U Hartford	5
165	U Utah	5
165	Louisiana Tech University	5
165	California Institute of Technology	5
165	U Wisconsin-Milwaukee	5
165	U Tulsa	5
165	Wright State University	5
165	US Merchant Marine Academy	5
165	Hofstra University	5
186	Central State University	4
186	Portland State University	4
186	Virginia Military Institute	4
186	U Nevada-Las Vegas	4
186	U Lowell	4
186	Yale University	4
186	U Colorado-Colorado Springs	4
186	Wichita State University	4
186	Villanova University	4
186	U Tennessee-Chattanooga	4
186	U North Carolina-Charlotte	4
186	U South Alabama	4
186	Harvey Mudd College	4
186	SUNY-Maritime College	4
186	Tennessee Tech University	4
186	U Mississippi	4
186	Indiana U-Purdue Indiana	4
186	U New Haven	4
186	U Southwestern Louisiana	4
205	Catholic University of America	3
205	Bridgeport Engineering Institute	3
205	U Kentucky	3
205	Wentworth Institute of Technology	3
205	Union College	3
205	U Iowa	3
205	Bucknell University	3
205	U Wyoming	3
205	U Nebraska-Lincoln	3
205	McNeese State University	3
205	U Idaho	3
205	Northern Illinois University	3
205	US Coast Guard Academy	3
205	Bradley University	3
205	Alabama A&M University	3
205	West Virginia Institute Technology	3
205	Walla Walla College	3
205	SUNY-Binghamton	3
205	Lafayette College	3
205	Dartmouth College	3
205	Montana College Mining Science and Technology	3
205	U Massachusetts-Dartmouth	3
227	U Toledo	2
227	Trinity University	2
227	Tri-State University	2
227	Ferris State University	2
227	U Wisconsin-Platteville	2
227	North Dakota State University	2
227	Gonzaga University	2
227	U Nevada-Reno	2
227	U Maryland-Baltimore	2
227	Saginaw Valley State University	2
227	St Ambrose University	2
227	Embry Riddle U-Prescott	2
227	SUNY-New Paltz	2
227	Western Michigan University	2
227	Monmouth College	2
227	Rose-Hulman Institute of Technology	2
227	U Cal-Santa Cruz	2
227	California Maritime Academy	2
245	South Dakota School of Mines & Technology	1
245	Baylor University	1
245	College of Staten Island	1
245	Swarthmore College	1
245	U Akron	1
245	U Georgia	1
245	Trinity College	1
245	New Mexico Highlands University	1
245	Texas A&M University-Galveston	1
245	Le Tourneau University	1
245	U Portland	1
245	Ohio Northern University	1
245	U North Dakota	1
245	U New Hampshire	1
245	Western New England College	1
245	U Alaska-Anchorage	1
245	U Bridgeport	1
245	Humboldt State University	1
245	Idaho State University	1
245	Mass Maritime Academy	1
245	Gannon University	1
245	U Vermont	1
245	Norwich University	1
245	Wilkes University	1
245	Geneva College	1
245	U Nevada-School of Mines	1
245	Oral Roberts University	1
245	Valparaiso University	1
245	U Minnesota-Duluth	1
245	Grand Valley State University	1
245	Calvin College	1
245	Montana State University	1
245	U Denver	1
245	US International University	1
245	Arkansas State University	1
280	South Dakota State University	0
280	Northeastern State University	0
280	Seattle University	0
280	Citadel	0
280	Alfred U/SUNY Ceramics	0
280	U Hawaii	0
280	Arkansas Tech University	0
280	U Maine-Orono	0
280	Indiana Institute of Technology	0
280	U Redlands	0
280	U West Florida	0
280	Merrimack College	0
280	Oklahoma Christian University	0
280	Utah State University	0
280	U Texas-Permian Basin	0
280	Messiah College	0
280	U Scranton	0
280	Philadelphia College of Textiles	0
280	Cogswell College North	0
280	Grove City College	0
280	Oregon State University	0
280	Washington & Lee University	0
280	West Virginia Grad College	0
280	Pacific Lutheran University	0
280	Dordt College	0
280	U of Southern Maine	0
280	Loras College	0
280	Cogswell College	0
280	U Cal-Riverside	0
280	Seattle Pacific University	0
280	U Wisconsin-Parkside	0
280	St Martins College	0
280	Oregon Grad Institute Science and Technology	0
280	Maine Maritime Academy	0
280	Youngstown State University	0
280	U Southern Colorado	0
280	Indiana U-Purdue Ft Wayne	0
280	Institute of Paper Science & Technology	0
280	Hartford Graduate Center	0
280	West Coast University	0
280	National Tech University	0
280	U Akron-Polymer Science	0
280	US Naval Postgraduate	0
280	John Brown University	0
280	U Alaska-Fairbanks	0
280	U Evansville	0
280	Loyola College	0
280	Mankato State University	0
280	St Cloud State University	0
280	Miami University	0
280	Marietta College	0
280	Air Force Institute of Technology	0
280	U North Carolina-Chapel Hill	0
280	Webb Institute of Naval Architecture	0
280	SUNY-College of Environmental Science	0
280	New England College	0
280	Washington University (STIM)	0
280	U St Thomas	0
	Capitol College	NA
	Trenton State College	NA
	Roger Williams University	NA

NA= not available

* Engineering institutions included in the Engineering Workforce Commission (EWC) database but excludes University of Puerto Rico. Averages were calculated from available data and rounded to nearest integer. Schools with averages of .5 or lower were given an average of 0 minorities. Not all institutional averages include three years.

Table 2.

Graduation Rate and Relative Retention Index for Engineering Institutions,* Listed Alphabetically

Institution	Minority Graduation Rate (%)	Nonminority Graduation Rate (%)	Relative Retention Index (%)	Average Minority Freshman Class (1988-89) (N)	Average Minority Graduating Class (1990-93) (N)	Average Nonminority Freshman Class (1988-89) (N)	Average Nonminority Graduating Class (1990-93) (N)
Arkansas State University	6.7	20.6	32.4	10	1	117	24
Auburn University	33.0	62.2	53.1	69	23	1025	637
Boston University	63.9	67.3	95.0	32	21	406	273
Case Western Reserve University	79.2	39.6	199.8	16	13	537	213
CCNY (City College, CUNY)	19.6	37.8	51.9	471	92	506	191
Christian Brothers University	36.1	42.4	85.1	24	9	104	44
Clemson University	35.8	50.0	71.6	87	31	924	462
Colorado School of Mines	52.0	57.3	90.7	25	13	429	246
Colorado State University	47.5	64.2	74.0	20	10	302	194
Columbia University	105.9	96.9	109.2	17	18	229	222
Cornell University	47.7	86.3	55.3	79	38	655	565
Drexel University	46.4	65.6	70.8	51	24	658	431
Duke University	75.0	70.9	105.8	16	12	257	182
Florida Institute of Technology	77.4	50.5	153.1	28	22	309	156
Georgia Institute of Technology	70.3	68.6	102.5	171	120	1555	1067
GMI Engineering & Management Institute	61.8	75.6	81.8	37	23	424	321
Howard University	54.5	18.4	295.6	200	109	47	9
Iowa State University	22.3	45.3	49.3	40	9	1441	653
Johns Hopkins University	74.3	92.1	80.6	12	9	199	183
Kansas State University	26.3	47.1	55.8	32	8	672	317
Lawrence Technological University	32.4	60.8	53.4	49	16	521	316
Lehigh University	57.8	87.4	66.1	15	9	410	358
Louisiana State University	19.5	36.5	53.5	108	21	645	235
Loyola Marymount University	45.5	45.7	99.5	18	8	81	37
Manhattan College	41.1	60.7	67.6	32	13	284	173
Marquette University	42.9	74.5	57.5	23	10	389	290
McNeese State University	25.0	22.4	111.8	12	3	85	19
Memphis State University	26.2	65.6	40.0	47	12	161	105
Michigan State University	15.6	53.1	29.3	229	36	1049	557
Milwaukee School of Engineering	34.8	48.1	72.3	15	5	389	187
Mississippi State University	39.3	73.3	53.6	71	28	402	295
North Carolina A&T State University	56.0	57.9	96.7	233	130	42	24
North Carolina State U Raleigh	35.7	77.6	46.0	222	79	1210	940
New Mexico State University	34.2	48.3	70.8	177	61	368	178
Northeastern University	51.9	80.6	64.4	35	18	495	399
Northern Arizona University	14.0	39.2	35.8	38	5	204	80
Northwestern University	80.0	102.1	78.3	33	27	252	258
Oakland University	32.7	86.9	37.7	18	6	162	141
Ohio State University	17.2	35.3	48.6	146	25	1913	676
Ohio University	27.4	59.8	45.8	24	7	278	166
Oklahoma State University	23.5	43.1	54.5	40	9	459	198
Old Dominion University	51.6	77.5	66.6	21	11	207	161
Penn State University	29.1	46.2	62.9	96	28	2581	1193
Polytechnic University	66.0	49.1	134.5	53	35	505	248
Purdue University	54.1	71.5	75.6	99	53	1571	1123
Purdue U-Calumet	36.4	59.2	61.5	15	5	73	43
Rensselaer Polytechnic Institute	50.2	83.2	60.3	87	44	709	590
Rice University	41.2	80.7	51.0	28	12	188	152
Rochester Institute of Technology	27.3	62.6	43.6	18	5	358	224
Rutgers University	28.6	68.4	41.8	93	27	603	413
San Francisco State University	30.3	45.0	67.3	36	11	200	90
Santa Clara University	65.2	74.9	87.0	15	10	150	113
Southern Illinois-Carbondale	18.9	60.4	31.3	30	6	273	165
SUNY-Buffalo	35.7	55.8	63.9	38	14	824	460
SUNY-Maritime College	34.4	61.2	56.1	11	4	96	59
Syracuse University	47.1	54.8	86.1	23	11	293	161
Tennessee State University	18.3	60.6	30.3	202	37	60	36

Institution	Minority Graduation Rate (%)	Nonminority Graduation Rate (%)	Relative Retention Index (%)	Average Minority Freshman Class (1986-89) (N)	Average Minority Graduating Class (1990-93) (N)	Average Nonminority Freshman Class (1986-89) (N)	Average Nonminority Graduating Class (1990-93) (N)
Tennessee Tech University	16.9	45.3	37.4	22	4	491	222
Texas Tech University	19.5	47.1	41.4	68	13	407	192
Tulane University	51.8	63.3	81.9	28	14	191	121
Tuskegee University	37.3	46.4	80.4	251	94	9	4
U Akron	2.7	26.8	10.2	49	1	769	206
U Alabama	21.0	38.6	54.5	128	27	570	220
U Alabama-Birmingham	36.4	86.9	41.8	18	7	99	86
U Arizona	24.1	52.2	46.1	156	38	814	425
U Arkansas	25.5	47.9	53.2	50	13	467	224
U California-Irvine	70.2	73.8	95.0	19	13	251	185
U California-San Diego	17.1	43.5	39.2	121	21	888	386
U California-Santa Barbara	33.3	62.7	53.1	50	17	319	200
U Cincinnati	44.3	62.5	70.9	20	9	535	334
U Colorado-Boulder	38.6	65.9	58.6	53	20	601	396
U Connecticut	19.2	60.0	32.1	26	5	401	240
U Dayton	103.3	57.8	178.8	10	10	310	179
U Delaware	56.5	56.4	100.1	36	20	290	164
U Detroit	51.4	78.4	65.6	12	6	86	68
U Houston	45.7	77.8	58.7	42	19	239	186
U Iowa	24.4	57.9	42.1	14	3	397	230
U Kansas	27.2	49.7	54.7	27	7	536	266
U Louisville	47.1	62.9	74.9	23	11	279	175
U Massachusetts-Amherst	55.6	67.3	82.5	27	15	430	290
U Massachusetts-Lowell	34.2	42.5	80.4	13	4	737	314
U Miami	63.3	60.8	104.1	63	40	199	121
U Michigan-Ann Arbor	53.6	93.4	57.4	83	44	856	799
U Minnesota	32.6	93.4	34.9	29	9	723	675
U Mississippi	32.4	66.8	48.5	11	4	112	75
U Missouri-Columbia & KC	21.8	68.3	32.0	58	13	523	357
U Missouri-Rolla	36.8	73.7	50.0	44	16	784	578
U North Carolina-Charlotte	30.0	54.7	54.9	13	4	221	121
U Notre Dame	38.0	59.9	63.4	26	10	357	214
U Oklahoma	28.4	62.1	45.7	56	16	459	291
U Pittsburgh	34.7	77.9	44.6	39	14	388	302
U Rhode Island	105.6	59.8	176.5	12	13	243	145
U Rochester	41.3	53.0	78.0	15	6	258	137
U South Alabama	15.9	38.8	41.0	23	4	218	85
U South Carolina	14.3	47.1	30.3	79	11	350	165
U Southern California	43.9	43.2	101.6	52	23	597	258
U Southwestern Louisiana	9.2	43.3	21.3	40	4	230	100
U Texas-Arlington	38.6	66.0	58.4	51	20	425	280
U Texas-Austin	32.1	60.9	52.7	259	83	1019	620
U Texas-El Paso	25.4	45.9	55.3	326	83	170	78
U Toledo	6.2	33.1	18.7	38	2	677	224
U Utah	41.2	75.1	54.8	11	5	347	261
U Virginia	51.1	74.4	68.7	44	22	404	301
U Washington	39.2	75.2	52.2	87	34	825	620
U Wisconsin-Madison	44.6	81.0	55.1	25	11	734	595
U Wisconsin-Milwaukee	42.4	79.6	53.3	11	5	245	195
US Naval Academy	40.5	36.3	111.5	77	31	940	341
Vanderbilt University	46.3	68.3	67.8	27	13	288	197
Virginia Polytechnic Institute	41.8	68.9	60.7	67	28	1276	879
Western Michigan University	10.6	70.0	15.2	16	2	228	159
Wichita State University	25.5	57.8	44.1	17	4	258	149
Wright State University	16.5	49.5	33.3	28	5	320	158

*Sample Selection Criteria. 1) Engineering institutions included in the Engineering Workforce Commission (EWC) database. 2) Schools with complete data. 3) A yearly average minority freshman class of at least 10. 4) Increases in minority or nonminority freshman-to-sophomore enrollments not exceeding 15 percent.

Table 3.

Engineering Institutions* Ranked by Minority Graduation Rates

Institution	Minority Graduation Rate (2)	Nonminority Graduation Rate (2)	Relative Retention Index (2)
Columbia University	105.9	96.9	109.2
U Rhode Island	105.6	59.8	176.5
U Dayton	103.3	57.8	178.8
Northwestern University	80.0	102.1	78.3
Case Western Reserve University	79.2	39.6	199.8
Florida Institute of Technology	77.4	50.5	153.1
Duke University	75.0	70.9	105.8
Johns Hopkins University	74.3	92.1	80.6
Georgia Institute of Technology	70.3	68.6	102.5
U California-Irvine	70.2	73.8	95.0
Polytechnic University	66.0	49.1	134.5
Santa Clara University	65.2	74.9	87.0
Boston University	63.9	67.3	95.0
U Miami	63.3	60.8	104.1
GMI Engineering & Management Institute	61.8	75.6	81.8
Lehigh University	57.8	87.4	66.1
U Delaware	56.5	56.4	100.1
North Carolina A&T State University	56.0	57.9	96.7
U Massachusetts-Amherst	55.6	67.3	82.5
Howard University	54.5	18.4	295.6
Purdue University	54.1	71.5	75.6
U Michigan-Ann Arbor	53.6	93.4	57.4
Colorado School of Mines	52.0	57.3	90.7
Northeastern University	51.9	80.6	64.4
Tulane University	51.8	63.3	81.9
Old Dominion University	51.6	77.5	66.6
U Detroit	51.4	78.4	65.6
U Virginia	51.1	74.4	68.7
Rensselaer Polytechnic Institute	50.2	83.2	60.3
Cornell University	47.7	86.3	55.3
Colorado State University	47.5	64.2	74.0
Syracuse University	47.1	54.8	86.1
U Louisville	47.1	62.9	74.9
Drexel University	46.4	65.6	70.8
Vanderbilt University	46.3	68.3	67.8
U Houston	45.7	77.8	58.7
Loyola Marymount University	45.5	45.7	99.5
U Wisconsin-Madison	44.6	81.0	55.1
U Cincinnati	44.3	62.5	70.9
U Southern California	43.9	43.2	101.6
Marquette University	42.9	74.5	57.5
U Wisconsin-Milwaukee	42.4	79.6	53.3
Virginia Polytechnic Institute	41.8	68.9	60.7
U Rochester	41.3	53.0	78.0
Rice University	41.2	80.7	51.0
U Utah	41.2	75.1	54.8
Manhattan College	41.1	60.7	67.6
US Naval Academy	40.5	36.3	111.5
Mississippi State University	39.3	73.3	53.6
U Washington	39.2	75.2	52.2
U Colorado-Boulder	38.6	65.9	58.6
U Texas-Arlington	38.6	66.0	58.4
U Notre Dame	38.0	59.9	63.4
Tuskegee University	37.3	46.4	80.4
U Missouri-Rolla	36.8	73.7	50.0
Purdue U-Calumet	36.4	59.2	61.5
U Alabama-Birmingham	36.4	86.9	41.8
Christian Brothers University	36.1	42.4	85.1
Clemson University	35.8	50.0	71.6
North Carolina State U-Raleigh	35.7	77.6	46.0
SUNY-Buffalo	35.7	55.8	63.9
Milwaukee School of Engineering	34.8	48.1	72.3
U Pittsburgh	34.7	77.9	44.6
SUNY-Maritime College	34.4	61.2	56.1
U Massachusetts-Lowell	34.2	42.5	80.4
New Mexico State University	34.2	48.3	70.8
U California-Santa Barbara	33.3	62.7	53.1
Auburn University	33.0	62.2	53.1
Oakland University	32.7	86.9	37.7
U Minnesota	32.6	93.4	34.9
Lawrence Technological University	32.4	60.8	53.4
U Mississippi	32.4	66.8	48.5
U Texas-Austin	32.1	60.9	52.7
San Francisco State University	30.3	45.0	67.3
U North Carolina-Charlotte	30.0	54.7	54.9
Penn State University	29.1	46.2	62.9
Rutgers University	28.6	68.4	41.8
U Oklahoma	28.4	62.1	45.7
Ohio University	27.4	59.8	45.8
Rochester Institute of Technology	27.3	62.6	43.6
U Kansas	27.2	49.7	54.7
Kansas State University	26.3	47.1	55.8
Memphis State University	26.2	65.6	40.0
U Arkansas	25.5	47.9	53.2
Wichita State University	25.5	57.8	44.1
U Texas-El Paso	25.4	45.9	55.3
McNeese State University	25.0	22.4	111.8
U Iowa	24.4	57.9	42.1
U Arizona	24.1	52.2	46.1
Oklahoma State University	23.5	43.1	54.5
Iowa State University	22.3	45.3	49.3
U Missouri-Columbia & KC	21.8	68.3	32.0
U Alabama	21.0	38.6	54.5
CCNY (City College, CUNY)	19.6	37.8	51.9
Texas Tech University	19.5	47.1	41.4
Louisiana State University	19.5	36.5	53.5
U Connecticut	19.2	60.0	32.1
Southern Illinois U-Carbondale	18.9	60.4	31.3
Tennessee State University	18.3	60.6	30.3
Ohio State University	17.2	35.3	48.6
U California-San Diego	17.1	43.5	39.2
Tennessee Tech University	16.9	45.3	37.4
Wright State University	16.5	49.5	33.3
U South Alabama	15.9	38.8	41.0
Michigan State University	15.6	53.1	29.3
U South Carolina	14.3	47.1	30.3
Northern Arizona University	14.0	39.2	35.8
Western Michigan University	10.6	70.0	15.2
U Southwestern Louisiana	9.2	43.3	21.3
Arkansas State University	6.7	20.6	32.4
U Toledo	6.2	33.1	18.7
U Akron	2.7	3.7	10.2

*Sample Selection Criteria: 1) Engineering institutions included in the Engineering Workforce Commission (EWC) database. 2) Schools with complete data. 3) A yearly average minority freshman class of at least 10. 4) Increases in minority or nonminority freshman-to-sophomore enrollments not exceeding 15 percent.

Table 4.

Engineering Institutions* Ranked by Relative Retention Index

Institution	Relative Retention Index [2]	Minority Graduation Rate [2]	Nonminority Graduation Rate [2]
Howard University	295.6	54.5	18.4
Case Western Reserve University	199.8	79.2	39.6
U Dayton	178.8	103.3	57.8
U Rhode Island	176.5	105.6	59.8
Florida Institute of Technology	153.1	77.4	50.5
Polytechnic University	134.5	66.0	49.1
McNeese State University	111.8	25.0	22.4
US Naval Academy	111.5	40.5	36.3
Columbia University	109.2	105.9	96.9
Duke University	105.8	75.0	70.9
U Miami	104.1	63.3	60.8
Georgia Institute of Technology	102.5	70.3	68.6
U Southern California	101.6	43.9	43.2
U Delaware	100.1	56.5	56.4
Loyola Marymount University	99.5	45.5	45.7
North Carolina A&T State University	96.7	56.0	57.9
U Cal-Irvine	95.0	70.2	73.8
Boston University	95.0	63.9	67.3
Colorado School of Mines	90.7	52.0	57.3
Santa Clara University	87.0	65.2	74.9
Syracuse University	86.1	47.1	54.8
Christian Brothers University	85.1	36.1	42.4
U Massachusetts-Amherst	82.5	55.6	67.3
Tulane University	81.9	51.8	63.3
GMI Engineering & Management Institute	81.8	61.8	75.6
Johns Hopkins University	80.6	74.3	92.1
U Massachusetts-Lowell	80.4	34.2	42.5
Tuskegee University	80.4	37.3	46.4
Northwestern University	78.3	80.0	102.1
U Rochester	78.0	41.3	53.0
Purdue University	75.6	54.1	71.5
U Louisville	74.9	47.1	62.9
Colorado State University	74.0	47.5	64.2
Milwaukee School of Engineering	72.3	34.8	48.1
Clemson University	71.6	35.8	50.0
U Cincinnati	70.9	44.3	62.5
New Mexico State University	70.8	34.2	48.3
Drexel University	70.8	46.4	65.6
U Virginia	68.7	51.1	74.4
Vanderbilt University	67.8	46.3	68.3
Manhattan College	67.6	41.1	60.7
San Francisco State University	67.3	30.3	45.0
Old Dominion University	66.6	51.6	77.5
Lehigh University	66.1	57.8	87.4
U Detroit	65.6	51.4	78.4
Northeastern University	64.4	51.9	80.6
SUNY-Buffalo	63.9	35.7	55.8
U Notre Dame	63.4	38.0	59.9
Penn State University	62.9	29.1	46.2
Purdue U-Calumet	61.5	36.4	59.2
Virginia Polytechnic Institute	60.7	41.8	68.9
Rensselaer Polytechnic Institute	60.3	50.2	83.2
U Houston	58.7	45.7	77.8
U Colorado-Boulder	58.6	38.6	65.9
U Texas-Arlington	58.4	38.6	66.0
Marquette University	57.5	42.9	74.5
U Michigan-Ann Arbor	57.4	53.6	93.4
SUNY-Maritime College	56.1	34.4	61.2
Kansas State University	55.8	26.3	47.1
U Texas-El Paso	55.3	25.4	45.9
Cornell University	55.3	47.7	86.3
U Wisconsin-Madison	55.1	44.6	81.0
U North Carolina-Charlotte	54.9	30.0	54.7
U Utah	54.8	41.2	75.1
U Kansas	54.7	27.2	49.7
Oklahoma State University	54.5	23.5	43.1
U Alabama	54.5	21.0	38.6
Mississippi State University	53.6	39.3	73.3
Louisiana State University	53.5	19.5	36.5
Lawrence Technological University	53.4	32.4	60.8
U Wisconsin-Milwaukee	53.3	42.4	79.6
U Arkansas	53.2	25.5	47.9
U Cal-Santa Barbara	53.1	33.3	62.7
Auburn University	53.1	33.0	62.2
U Texas-Austin	52.7	32.1	60.9
U Washington	52.2	39.2	75.2
CCNY (City College, CUNY)	51.9	19.6	37.8
Rice University	51.0	41.2	80.7
U Missouri-Rolla	50.0	36.8	73.7
Iowa State University	49.3	22.3	45.3
Ohio State University	48.6	17.2	35.3
U Mississippi	48.5	32.4	66.8
U Arizona	46.1	24.1	52.2
North Carolina State U-Raleigh	46.0	35.7	77.6
Ohio University	45.8	27.4	59.8
U Oklahoma	45.7	28.4	62.1
U Pittsburgh	44.6	34.7	77.9
Wichita State University	44.1	25.5	57.8
Rochester Institute of Technology	43.6	27.3	62.6
U Iowa	42.1	24.4	57.9
U Alabama-Birmingham	41.8	36.4	86.9
Rutgers University	41.8	28.6	68.4
Texas Tech University	41.4	19.5	47.1
U South Alabama	41.0	15.9	38.8
Memphis State University	40.0	26.2	65.6
U Cal-San Diego	39.2	17.1	43.5
Oakland University	37.7	32.7	86.9
Tennessee Tech University	37.4	16.9	45.3
Northern Arizona University	35.8	14.0	39.2
U Minnesota	34.9	32.6	93.4
Wright State University	33.3	16.5	49.5
Arkansas State University	32.4	6.7	20.6
U Connecticut	32.1	19.2	60.0
U Missouri-Columbia & KC	32.0	21.8	68.3
Southern Illinois U-Carbondale	31.3	18.9	60.4
U South Carolina	30.3	14.3	47.1
Tennessee State University	30.3	18.3	60.6
Michigan State University	29.3	15.6	53.1
U Southwestern Louisiana	21.3	9.2	43.3
U Toledo	18.7	6.2	33.1
Western Michigan University	15.2	10.6	70.0
U Akron	10.2	2.7	26.8

*Sample Selection Criteria: 1) Engineering institutions included in the Engineering Workforce Commission (EWC) database. 2) Schools with complete data. 3) A yearly average minority freshman class of at least 10. 4) Increases in minority or nonminority freshman-to-sophomore enrollments not exceeding 15 percent.

Table 5.
Engineering Institutions* with Selected Institutional Characteristics

	Institutional Control†	College Cost‡ ($)	Selectivity†	Engineering Programs Offered**	Support Programs Offered**
HBCUs and HACUs					
CCNY (City College, CUNY)	Public	2,543	3	4	4
Howard University	Private	6,981	3	4	5
North Carolina A&T State University	Public	1,270	3	7	3
New Mexico State University	Public	1,756	3	7	6
Prairie View A&M University	Public	1,196	3	3	5
Southern University	Public	1,588	1	3	5
Tennessee State University	Public	1,632	2	4	5
Tuskegee University	Private	6,535	2	4	4
U Texas-El Paso	Public	1,077	2	5	4
Category Average		2,731		4.6	4.6
Research Institutions					
Cornell University	Private	17,264	5	8	5
Georgia Institute of Technology	Public	2,205	4	12	6
North Carolina State U-Raleigh	Public	1,344	3	12	4
Northwestern University	Private	15,075	4	8	4
Ohio State University	Public	2,799	3	10	4
Penn State University	Public	4,618	4	16	5
Purdue University	Public	2,520	3	13	5
Rensselaer Polytechnic Institute	Private	17,225	4	12	5
Rice University	Private	9,650	5	5	5
U Michigan-Ann Arbor	Public	4,285	4	10	6
U Southern California	Private	16,020	3	6	4
U Texas-Austin	Public	1,372	4	9	6
U Wisconsin-Madison	Public	2,346	3	10	5
Virginia Polytechnic Institute	Public	4,004	3	13	3
Category Average		7,195		10.3	4.8
Predominantly Nonminority Institutions					
Arkansas State University	Public	1,620	2	2	2
Auburn University	Public	1,755	3	9	4
Boston University	Private	17,650	3	7	4
Brigham Young University	Private	2,120	3	4	2
Brown University	Private	17,865	5	6	NA
Bucknell University	Private	17,730	4	4	4
Case Western Reserve University	Private	15,320	4	10	5
Catholic University of America	Private	12,986	3	4	2
Christian Brothers University	Private	8,090	3	4	4
Citadel	Public	3,389	3	2	0
Clarkson University	Private	14,510	4	5	6
Clemson University	Public	2,762	3	9	3
Colorado School of Mines	Public	4,504	4	8	6
Colorado State University	Public	2,511	4	6	6
Columbia University	Private	16,928	5	8	5
Cooper Union	Private	300	5	4	5
Dartmouth College	Private	18,270	5	1	3
Drexel University	Private	11,635	3	6	4
Duke University	Private	17,160	5	4	2
Florida Institute of Technology	Private	13,035	3	8	1
GMI Engineering & Management Institute	Private	10,240	4	4	4
George Washington University	Private	16,080	3	5	5
Gonzaga University	Private	12,300	3	3	1
Harvey Mudd College	Private	15,920	5	1	2
Iowa State University	Public	2,352	3	13	6
Johns Hopkins University	Private	17,900	5	7	4
Kansas State University	Public	1,699	1	10	5
Lafayette College	Private	16,795	4	4	4
Lawrence Technological University	Private	5,970	3	3	3
Le Tourneau University	Private	8,460	3	1	2
Lehigh University	Private	17,750	4	7	5
Louisiana State University	Public	2,173	3	8	4
Loyola Marymount University	Private	13,060	3	3	3
Manhattan College	Private	12,300	3	5	NA
Marietta College	Private	13,170	3	1	0
Marquette University	Private	9,934	3	5	3
McNeese State University	Public	1,934	1	1	NA
Memphis State University	Public	1,546	3	3	3
Michigan State University	Public	3,905	3	6	6
Milwaukee School of Engineering	Private	9,960	3	6	6
Mississippi State University	Public	2,950	3	11	3
Montana College Mining Sci/Tech	Public	1,809	3	7	1
Montana State University	Public	1,820	3	6	4
North Dakota State University	Public	2,033	3	6	3
Northeastern University	Private	11,489	3	5	4
Northern Arizona University	Public	1,590	3	4	4
Norwich University	Private	13,240	3	3	1
Oakland University	Public	2,737	3	4	3
Ohio Northern University	Private	14,775	3	3	2
Ohio University	Public	3,234	3	5	4
Oklahoma State University	Public	1,694	3	9	5
Old Dominion University	Public	3,518	3	4	4
Oregon State University	Public	2,691	3	9	2
Polytechnic University	Private	14,780	4	8	4
Purdue U-Calumet	Public	2,766	1	2	5
Rochester Institute of Technology	Private	12,720	3	5	3
Rutgers University	Public	3,249	3	7	6
South Dakota School of Mines & Technology	Public	2,509	3	7	3

Index (RRI), which is the ratio of graduation rates of the two population groups. Table 4 ranks the 112 institutions by Relative Retention Index.

Institutional Characteristics

Retention in engineering school was examined in relation to five institutional characteristics: 1) institutional control (public versus private), 2) college cost, 3) selectivity, 4) number of accredited engineering programs, and 5) number of student support programs. For the first three parameters studied, institutional control, college cost and selectivity, data came from *Peterson's Guide to Four-Year Colleges*.[2] Counts of accredited engineering programs and student support programs came from *The ABET Accreditation Yearbook*[3] and *The ASEE Directory of Engineering and Engineering Technology Undergraduate Programs*[4] respectively.

We then looked at aggregated data for two unique groups of institutions: the Historically Black Colleges and Universities (HBCUs), as identified by the United Negro College Fund,[5] and the member institutions of the Hispanic Association of Colleges and Universities (HACU);[6] and the engineering research institutions, as identified by the *U.S. News and World Report* 1992 survey of higher education.[7] The remaining institutions were classified as predominantly nonminority.

To provide as large a data base as possible, this portion of the study included all schools enrolling one or more minority freshmen during the entering cohort years of 1986 to 1989, expanding the sample to a total of 162. Table 5 lists the sample schools by category and provides information on selected institutional characteristics.

1) *Institutional Control: Public vs. Private*

Institutional control refers to an institution's primary funding source, which can be public or private. Public institutions are those that receive substantial funding from federal, state, and/or local governments. Private institutions

	Institutional Control	College Cost ($)	Selectivity	Engineering Programs Offered	Support Programs Offered
SUNY-Buffalo	Public	3,020	4	6	4
SUNY-Maritime College	Public	2,990	3	3	3
San Francisco State University	Public	1,514	3	3	5
Santa Clara University	Private	12,150	3	4	3
Southern Illinois U-Carbondale	Public	3,006	3	4	6
Stevens Institute of Technology	Private	16,575	4	9	NA
Syracuse University	Private	13,813	4	7	4
Tennessee Tech University	Public	1,634	3	5	3
Texas A&M U-Galveston	Public	1,402	3	1	NA
Texas Tech University	Public	1,490	3	8	6
Tri-State University	Private	9,018	3	5	4
Trinity University	Private	11,720	4	1	2
Tulane University	Private	18,755	4	5	4
U Akron	Public	2,821	1	4	2
U Alabama	Public	2,068	3	6	3
U Alabama-Birmingham	Public	2,238	3	4	3
U Arizona	Public	1,615	3	13	5
U Arkansas	Public	1,918	2	7	3
U Bridgeport	Private	12,425	3	3	2
U California-Irvine	Public	3,076	4	3	5
U California-San Diego	Public	3,013	4	6	6
U California-Santa Barbara	Public	2,983	4	4	5
U Cincinnati	Public	1,642	3	11	4
U Colorado-Boulder	Public	2,540	3	7	6
U Colorado-Colorado Springs	Public	5,760	3	1	1
U Connecticut	Public	3,902	3	5	3
U Dayton	Private	10,210	3	4	4
U Delaware	Public	3,757	3	4	3
U Detroit	Private	10,180	3	4	NA
U Evansville	Private	10,700	3	2	1
U Hawaii	Public	1,498	3	3	1
U Houston	Public	6,250	NA	5	4
U Idaho	Public	3,242	3	8	2
U Iowa	Public	2,229	3	6	4
U Kansas	Public	1,798	3	9	5
U Louisville	Public	1,880	3	6	4
U Maine-Orono	Public	3,085	3	8	1
U Massachusetts-Amherst	Public	5,062	3	8	5
U Massachusetts-Dartmouth	Public	3,163	3	4	3
U Massachusetts-Lowell	Public	4,513	3	6	4
U Miami	Private	15,870	3	6	2
U Michigan-Dearborn	Public	2,934	3	3	3
U Minnesota	Public	3,158	3	9	4
U Mississippi	Public	2,435	3	5	3
U Missouri-Columbia & KC	Public	3,012	3	10	5
U Missouri-Rolla	Public	3,266	3	12	5
U North Carolina-Charlotte	Public	1,191	3	3	2
U Nevada-Reno	Private	1,665	3	7	NA
U Notre Dame	Private	14,997	5	6	3
U Oklahoma	Public	1,775	3	9	3
U Pittsburgh	Public	4,922	3	7	3
U Rhode Island	Public	3,540	3	7	4
U Rochester	Private	16,444	4	3	4
U South Alabama	Public	2,295	3	4	2
U South Carolina	Public	3,068	3	4	3
U Southwestern Louisiana	Public	1,782	1	5	NA
U Tennessee-Chattanooga	Public	1,670	3	1	2
U Texas-Arlington	Public	1,580	3	6	3
U Toledo	Public	3,008	3	7	3
U Tulsa	Private	9,380	3	5	1
U Utah	Public	2,104	3	8	6
U Vermont	Public	6,150	3	3	2
U Virginia	Public	3,890	4	7	5
U Washington	Public	3,042	3	9	6
U Wisconsin-Milwaukee	Public	2,393	3	5	6
U Wyoming	Public	1,430	3	7	3
US Merchant Marine Academy	Public	0	3	1	1
US Naval Academy	Public	0	4	7	3
Utah State University	Public	1,821	3	5	3
Valparaiso University	Private	10,840	3	4	2
Vanderbilt University	Private	16,247	4	5	3
Villanova University	Private	13,390	3	4	2
Virginia Military Institute	Public	4,640	3	3	1
West Virginia Institute of Technology	Public	1,784	1	4	0
West Virginia University	Public	1,928	3	9	3
Western Michigan University	Public	3,135	3	4	5
Western New England College	Private	8,426	3	3	1
Wichita State University	Public	1,903	1	4	3
Widener University	Private	11,770	3	5	1
Wilkes University	Private	9,868	3	2	4
Wright State University	Public	2,934	2	6	3
Category Average		6,558		5.4	3.2

*Engineering institutions included in the Engineering Workforce Commission (EWC) database with complete data that enrolled at least one minority freshman from 1986 to 1989

Sources:

Peterson's Guide to Four-Year Colleges 1994. Selectivity: 1 = noncompetitive, 2 = minimally competitive, 3 = moderately competitive, 4 = very competitive, 5 = most competitive. College cost does not include room and board.

**The 1992 *ABET Accreditation Yearbook*.

***The 1993 *ASEE Directory of Engineering and Engineering Technology Undergraduate Programs*.

NA=not available

are funded chiefly by non-governmental sources. In this study, almost two-thirds (101) of the sample schools were publicly controlled and just over one-third (61) privately controlled.

2) College Cost

College cost consists of full-time tuition plus mandatory fees for an academic year. Average college costs for the 101 public institutions were approximately $2,800. The 61 private institutions were more than four times as expensive, at about $12,700.[8]

3) Selectivity

Selectivity ratings are self assessments made by each college based on three criteria: percentage of applicants accepted, high school class rank and standardized test scores of freshmen who actually enrolled in the institution. The resulting descriptor places the school in one of five levels: noncompetitive, minimally difficult, moderately difficult, very difficult, and most difficult. As an example, at noncompetitive institutions: "virtually all applicants were accepted regardless of high school rank or test scores." In contrast, at the most difficult institutions: "more than 75 percent of entering freshmen were in the top 10 percent of their high school classes; they had a combined score over 1250 on the SAT or over 29 on the ACT; about 30 percent or less of those that applied were accepted".[9] The frequency distribution of schools in our sample among the levels of selectivity is shown in Table 6, with most schools falling in the moderately difficult category.

4) Number of Accredited Engineering Programs

Among the more than 20 engineering specializations available nationwide, the largest number of accredited programs at any institution in this study was 16, and the average was 5.8. Table 7 shows the frequency distribution of accredited programs.

5) Number of Support Programs

Support programs for minorities and

Table 6.
Distribution of Engineering Schools* in the Study Sample by Selectivity Status

Selectivity	Frequency	Percent
Noncompetitive	8	5.0
Minimally Difficult	6	3.7
Moderately Difficult	110	68.3
Very Difficult	27	16.8
Most Difficult	10	6.2
TOTAL	161	100.0

Table 7.
Distribution of Engineering Schools* in the Study Sample by Number of Engineering Programs

Number of Accredited Engineering Programs	Frequency	Percent
1	10	6.2
2	5	3.1
3	19	11.7
4	31	19.1
5	21	13.0
6	17	10.5
7	18	11.1
8	13	8.0
9	11	6.8
10 or more	17	10.5
TOTAL	162	100.0

Table 8.
Distribution of Engineering Schools* in the Study Sample by Number of Support Programs for Minorities and Women

Number of Support Programs for Minorities and Women	Frequency	Percent
0	3	1.9
1	13	8.4
2	19	12.3
3	37	24.0
4	36	23.4
5	28	18.2
6	18	11.7
TOTAL	154	100.0

*Engineering institutions included in the Engineering Workforce Commission (EWC) database with complete data.

women on the campuses of engineering schools were of two types, student chapters of national organizations or professional societies; and college/university-staffed programs. Student organizations for ethnic minorities or women in engineering included the American Indian Science and Engineering Society (AISES), the National Society of Black Engineers (NSBE), the Society of Mexican American Engineers and Scientists (MAES), the Society of Hispanic Professional Engineers (SHPE), and the Society of Women Engineers (SWE). College/university-staffed programs included any support programs run, but not necessarily funded, by the institution itself. Data on the number of support programs were available for 154 institutions. The mean number of support programs for these institutions was 3.6. Their frequency distribution is shown in Table 8.

Institutional Groups

The institutions examined in this analysis included nine HBCUs/HACUs and 14 research institutions, with the remaining 139 schools categorized as predominantly nonminority institutions. Each set of institutions is characterized in Table 9.

Institutional Characteristics and Minority Retention

For the entire sample of 162 institutions, the mean nonminority graduation rate of 62.3 percent was significantly higher than the mean minority graduation rate of 46.8 percent ($t(161) = 6.04$, $p < .000$). However, we found substantial differences in retention and relative retention when the data were correlated with institutional control, college cost, and selectivity.

Institutional Control

- Although public institutions graduated almost 2.7 times as many students as private institutions and offered their undergraduates a greater number of support programs, the mean minority graduation rate of 60.5 percent at private institutions was significantly higher than the mean minority graduation rate of 38.5 percent at public institutions ($t(116.79) = 4.00$, $p < .000$).

In fact, at 60.5 percent, private institutions graduated minority students at almost the same rate as nonminority students (64.9 percent), yielding a Relative Retention Index of 93.2 percent. By contrast, the mean minority graduation rate at public institutions (38.5 percent) was significantly lower than the mean nonminority graduation rate at the same schools (60.6 percent: $t(100) = 7.94$, $p < .000$), producing an RRI of 63.5 percent (see Figure 3). For nonminority students, there was no significant difference between graduation rates at public and private institutions.

It is not surprising that private engineering schools graduate a greater percentage of the minority students they enroll than do public institutions. Public institutions take much greater risks in enrolling students who may not have had the benefit of exemplary precollege preparation and whose financial needs may not be adequately met with institutional resources.

College Cost

- The highest cost institutions graduated minority engineering students at rates approaching those for nonminority students, as indicated by a Relative Retention Index of 89.5 percent (see Table 10). Low- and medium-cost schools graduated a significantly smaller percentage of minority students than nonminority students, as indicated by Relative Retention Indices of 68.4 and 65.7 percent respectively.

An examination of college costs at three levels: low (< $2,500), medium ($2,500 - $7,999), and high (> $8,000), found the mean minority graduation rate, at 59.4 percent, significantly greater at high cost colleges than at low and medium cost schools, where the graduation rates were 40.2 percent and 40.4 percent, respectively ($F(2, 161) = 5.92$, $p < .003$). The gap in graduation rates between minority and nonminority students at the same institution also narrowed at the highest cost schools, which had an RRI of 89.5

Figure 3.
Graduation Rate and Relative Retention Index
By Institutional Control
Percent

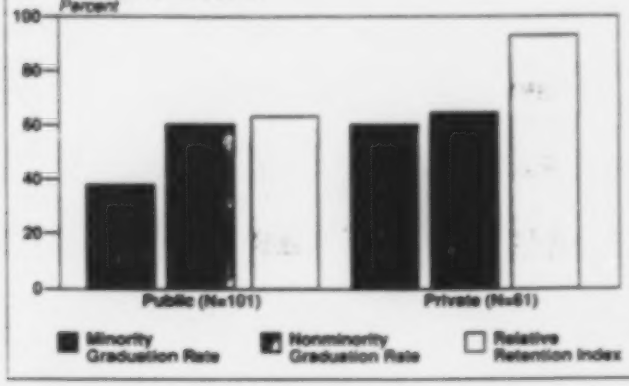


Figure 4.
Graduation Rates
HBCUs and HACUs
Percent

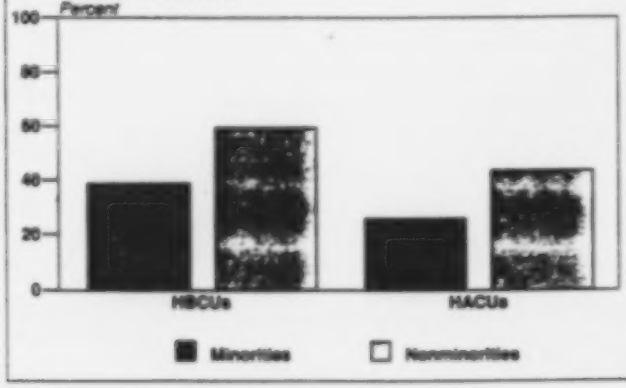


Table 9.
Summary of Institutional Types*

	Number of Institutions	Percent Public	Average College Cost	Average No. Engineering Programs Offered	Average No. Support Programs Offered
HBCUs and HACUs	9	78%	$2,731	4.6	4.6
Research Institutions	14	64%	$7,195	10.3	4.8
Predominantly Nonminority Institutions	139	61%	$6,558	5.4	3.2

* Engineering institutions included in the Engineering Workforce Commission (EWC) database with complete data and at least one minority freshman from 1986 to 1989

Table 10.
Graduation Rate and Relative Retention Index by College Cost*

College Cost	Mean Minority Graduation Rate	Mean Nonminority Graduation Rate	Mean Relative Retention Index
Low <$2500 (N = 53)	40.2%	58.8%	68.4%
Medium $2500 - $7900 (N = 54)	40.4%	61.5%	65.7%
High > $8000 (N = 55)	59.4%	66.4%	89.5%

* Engineering institutions included in the Engineering Workforce Commission (EWC) database with complete data and at least one minority freshman from 1986 to 1989

percent as compared to 65.7 at medium cost schools and 68.4 at the low cost institutions. Nonminority graduation rates did not differ widely by cost level. These findings overlap with the selectivity analysis, since there is a high correlation between cost and selectivity.

- Because private institutional control, college cost and selectivity are strongly associated with each other, we examined institutional performance as a function of cost after statistically controlling for selectivity and public/private status. With the data disaggregated, we found increasing college costs correlated with a lower Relative Retention Index.

Selectivity

- Among the variables examined for this study, selectivity of the institution was the most significant correlate of degree attainment for both minority and nonminority engineering students.

The more selective the institution, the higher the graduation rate for both minority and nonminority engineering students. But, unlike institutional control and college cost, which correlated primarily with minority retention, the association between selectivity and graduation rate was not only significant for minorities ($r = .29$, $p < .000$), it was even stronger for nonminorities ($r = .32$, $p < .000$). The Relative Retention Index was also positively correlated with selectivity, ($r = .20$, $p < .01$), indicating that the more selective schools graduate minority and nonminority students at about the same rates.

Number of Engineering Programs

While it might be expected that schools offering the largest variety of engineering disciplines would be more likely to graduate students because they provide a broad set of educational options, our analyses of minority student retention showed little correlation between the number of engineering programs offered and measures of degree attainment for students.

Number of Support Programs

The statistical correlations between the number of support programs offered

and the retention and relative retention of minority students were also insignificant. However, in qualitative explorations, we found administrators at several successful schools attributed their achievement in part to support programs that were perceived to be strong in fostering academic excellence or building a sense of community.

Institutional Groups

HBCUs and HACUs

The nine HBCUs/HACUs included in the sample produced a large proportion of the African American and Latino graduates who earned degrees during the period of the study, averaging 39.6 percent of the minority graduating class annually. Retention, however, at these schools, was almost exactly the same as the aggregate national graduation rates for all schools, for both minorities (35.0 percent) and nonminorities (59.3 percent), averaging 34.9 percent and 54.5 percent, respectively. When disaggregated, the data show the HBCUs somewhat above the national averages, graduating minorities at a rate of 39.2 percent and nonminorities at 59.7 percent, and the HACU schools falling below the average with minority and nonminority graduation rates of 26.4 and 44.0 percent respectively (Figure 4).

When schools were matched for selectivity, we found the minority graduation rate higher at predominantly nonminority institutions than at the predominantly minority colleges and universities.

Research Institutions

While the 14 research institutions we examined were among the most selective schools in the study, their minority and nonminority graduation rates of 45.8 and 71.3 percent, respectively, fell significantly below the top tier of highly selective schools, which have a minority graduation rate of 70.2 percent and a nonminority graduation rate of 78.5 percent. This may be attributable to the large size of research institutions, and the fact that teaching is not the primary focus of these schools. The gap in graduation rates between these two sets of institutions, however, was far more pronounced for the minority population, yielding a Relative Retention Index of 64.2 percent for the research institutions as compared to an RRI of 89.5 percent at the institutions categorized as most difficult. Even though research institutes were selective in their entrance requirements, provided a large number of accredited engineering programs and also a large number of support programs for minorities and women, as a group they did not graduate minorities at the same high rate as highly selective schools.

Multivariate Analyses

To determine which of the six institutional variables were the best predictors of success in retaining and graduating minority engineering students, we performed multivariate analyses, examining schools in the aggregate and by institutional group. Institutional control and selectivity were significant predictors of minority retention and, combined, explain 12 percent of the variance in minority graduation rates. Private institutions ($\beta = .41$, $p < .02$) and highly selective schools ($\beta = .20$, $p < .04$) were also associated with higher graduation rates for minority students. Selectivity ($\beta = .19$, $p < .05$), however, was the only significant predictor of higher retention among nonminorities, accounting for 9 percent of the variance in nonminority graduation rates. Institutional control ($\beta = .71$, $p < .0001$) and college costs ($\beta = -.47$, $p < .007$) were significantly associated with RRI. Thus, while private control was associated with greater equity between minority and nonminority graduation rates, increasing college costs were associated with lower relative retention of minority students.

Because the interrelationship among private institutional control, selectivity and college cost may mask their unique individual effects, we again conducted analyses in which the first two variables were statistically controlled, surfacing a different relationship between college costs and retention. After adjusting for the effects of selectivity and control on graduation rates, higher college costs were associated with a lower Relative Retention Index ($\beta = -.49$, $p < .005$). This suggests that higher college costs may be an attrition factor, even at the most successful institutions.

When we compared institutional groups — HBCUs/HACUs, research, and predominantly nonminority schools — higher college costs were associated with higher Relative Retention Indices ($\beta = .73$, $p < .03$) at the nine predominantly minority institutions, accounting for 46 percent of the variance in RRI. For predominantly nonminority institutions, higher selectivity was associated with higher minority graduation rates ($\beta = .24$, $p < .006$) and higher nonminority graduation rates ($\beta = .29$, $p < .001$). There were no significant predictors of success for research institutions.

Subjective Measures

To examine the qualitative factors that may account for differences in retention, we interviewed deans of engineering or their senior staff on eight campuses that had demonstrated success in retaining minority engineering students, as measured by RRI at the three research institutions and two predominantly nonminority institutions queried, and by minority graduation rate at the three predominantly minority institutions. To assure that total numbers were significant enough to warrant examination, schools selected for interviews had a minimum average annual output of 24 minority graduates.

We explored the efforts made to recruit and retain entering students, and to produce graduates, asking for descriptions of the factors perceived as contributing to each institution's achievement. A common set of responses emerged from the interviews including: 1) strong institutional commitment as evidenced by attitudes of faculty and staff, integral minority engineering programs, and allocation of resources; and 2) focus on removing barriers to student success. To a slightly lesser extent, most of the schools also credited: 1) involvement of the corporate community; 2) precollege development of potential engineering students; 3) summer bridge programs; and 4) special attention to early success of freshmen. All of the schools interviewed recruited transfer students, although the level of acceptance remained below 15 percent. Table 11 summarizes the

North Carolina Agricultural and Technical State University

The decision to reshape the achievement of students at North Carolina A&T State University resulted from the confluence of several factors: a decline in enrollment, the need to have a faculty that more closely resembled the student population, and the implementation of a new strategic plan. As the university assessed its learning environment, it found that about 75 percent of the faculty were foreign-born, and 40 percent of the students were women who felt alienated by the older male faculty, particularly those who were foreign-born. The institution deliberately sought a new faculty, one that looked more like the students — more women and more African Americans.

Beginning in 1989, North Carolina A&T entered a period of intense faculty recruitment which gained impetus as Ph.D.s became available due to industrial downsizing. Administrators interviewed widely, centralizing the function in the dean's office rather than with the department chairs. As part of the effort, the faculty reward system was revised, and a tenure plan developed based on effective teaching, advising, and research. Research is now not limited only to scientific discovery, but includes pedagogical innovation as well.

With the new faculty on board, the university's student recruitment strategies changed as well. The school developed promotional materials focusing on the faculty and new programs. It actively cultivated high school teachers and guidance counselors. Full scholarships were offered to high school valedictorians to increase the applicant pool and the acceptance rate.

The strategies have had a substantial impact. North Carolina A&T is now enrolling four out of five of its top recruits, students who used to go elsewhere. To attract the most academically prepared students, the school has revamped its financial aid policies, offering 124 merit-based scholarships out of 400 available scholarships. Standards for students overall have risen, with average SAT scores reaching 1,000, up from 850. The goal is 1,200. There is no longer an open admissions policy; GPAs and SATs are competitive with all North Carolina schools, except Duke. Despite the stringency of the new requirements, enrollment has gone from 668 undergraduates in 1988 to 1,270 in 1993.

North Carolina A&T's programs are backed by aggressively enlisted corporate funders who have increased their joint support from $500,000 to between $4 and $5 million annually.

Consistent with the pattern of other successful schools, North Carolina A&T operates middle and high school programs on campus and, in addition, has assigned a full time staff member to work on precollege math and science activities through SECME, the Southeastern Consortium for Minorities in Engineering.

North Carolina A&T's strategies move it some distance from the traditional mission of the HBCUs. Historically, these schools have seen their role as creating an environment of community, where all students can succeed, and where nurturing is an integral component. North Carolina A&T has made a tougher stance part of its principles: it no longer struggles to keep failing students on campus when the experience of leaving college for a low-paying job may lead students to return with a newly valued sense of the importance of an education.

they admit underqualified students to prestigious institutions, it is essential that we begin to examine the successes of these select colleges and universities in terms of institutional accomplishment rather than student adequacy.

There is no doubt that appropriate academic preparation is a critical ingredient to the achievement of any student about to embark on an undergraduate engineering education. But the engineering education community has spent some 20 years attempting to increase retention by remediating student deficiency, with little result. The crucial next step, if we are to have any impact on minority graduations beyond the highly selective, high cost, private institutions, is to distill and replicate the success factors shared by institutions that successfully promote retention. These link institutional commitment and adequate financial aid.

As with any effective organization in industry, government and the education community, institutional commitment is an essential precursor to achievement. During the course of this analysis, it became clear that the schools most successful at graduating minority engineers had strong commitment, evidenced in evaluation and planning, program development, allocation of resources, and attitudes and practices of faculty and staff. These institutions went to great lengths to understand the barriers that have had a negative impact on the performance of minority students, and invested significant time and resources to dismantle them.

According to deans and program directors, Minority Engineering Programs (MEPs) at committed institutions are adequately staffed by qualified personnel and positioned as critical components of the engineering school environment. Funded in large part as line items in the university budget, their role in the institution is to promote academic excellence and expand academic horizons within a community of students, not to remediate. Often responsible for the university's efforts to expand access, these MEPs cultivate future cohorts of students at a young age by providing early exposure to on-campus math and science enrichment programs, building potential applicants from the university's catchment area in the process. Students from these programs bring with them a realistic idea of what it means to be an engineer.

Whether discussing student recruitment, attitudes of faculty and staff or financial aid issues, administrators

characteristics to which these schools attributed their success.

At six of the eight schools, interviewees described idiosyncratic, highly distinctive programs that had been developed to address unique institutional barriers or to advance a particular institutional philosophy. They range from Drexel University's embracing of Total Quality Management, and the subsequent adoption of TQM by its SUCCESS program, to a focus on personal growth and leadership through student governance espoused by Rensselear Polytechnic Institute, to the establishment of an enriched scholarship program for high-achieving students at Prairie View A&M University. At Purdue University, a traditional Minority Engineering Program (MEP) expanded its offerings to meet a current challenge (see sidebar, page 15) and two universities — North Carolina A&T State University and Georgia Institute of Technology— described policy decisions to analyze institutional barriers and reshape results with minority students (see sidebars, pages 16 and 17). In addition, seven of the eight schools participated in two or more NACME scholarship programs.

Conclusions

The ability to provide access for large numbers of minority students while assuring their retention through graduation has proved an elusive combination for the institutions charged with educating the next generation of American engineers. The colleges and universities that have been most effective in graduating a significant percent of their minority freshmen are the same institutions that, on average, enroll minorities as an extremely small fraction of each year's entering class. Conversely, the large public universities and predominantly minority institutions that provide greater access to applicants from the minority communities, typically graduate these students at only two-thirds the rate of nonminority students. This is attributable in part to aggressive recruitment of able students whose financial need may not be adequately met with university resources or whose precollege academic preparation may not have been of the highest caliber.

While each set of institutions — and each individual institution — is constrained by broad differences in mission, objectives, finances and governance, an analysis of the variables most highly correlated with retention suggests a distinct institutional climate conducive to minority retention. Of the variables examined, three interrelated factors — high selectivity, private control, and high college cost — were most strongly associated with institutional success in retaining minority engineering students and with minority retention at rates approaching nonminority retention. Among the three factors, however, selectivity was the most consistent correlate across analyses: the most selective institutions graduated the highest percentage of minority engineering students. While this finding is important in challenging the notion that affirmative action programs fail because

Purdue University

Purdue University, one of the largest engineering schools in the country, maintains an extensive set of activities through its Minority Engineering Program (MEP). In existence since the early '70s the MEP is estimated to serve 75 to 80 percent of the available students. Although originally a marginalized program, Purdue's MEP now has full institutional commitment, with a full-time director, assistant director and secretary supported through the university budget.

Purdue starts early by providing training for local teachers and outreach to potential students through a series of summer engineering workshops. These include: two one-week workshops for seventh and eighth graders; PREFACE, a one-week summer workshop for ninth and tenth graders; and MITE, a two-week summer workshop for high school seniors. Approximately half the students participating in these programs enroll in Purdue; one-third of those stay in engineering.

Purdue offers freshmen a one-week summer bridge program in mathematics, as well as a 16-week fall semester freshman orientation course for one academic credit. The orientation places students in teams that do research, write reports and give presentations on topics related to the adjustment to college. They learn about banking, how to access student services, how to plan for graduate school or work, etc. Students comment that the teams help them make new friends early in the freshman year. Scheduled for Friday afternoons, the classes keep students from going home for the weekend, and help them learn to use this time for study.

Recently, Purdue noted that improved academic preparedness among its freshmen had not improved retention. In fact, students enrolling in engineering in the '90s were not doing as well as their predecessors of the '70s, although their credentials were better. The university decided to improve the overall GPA of minority engineering students by establishing a community of academic collaboration through the Academic Challenge Grant (ACG) program. The ACG sets a competition for a purse exceeding $4,000, in which the two ten-person teams having the highest GPA win. Participation is voluntary, and cuts across all years and disciplines.

The program focus is on team effort. No matter how good individual scores may be, if the team allows a member to fail, it may be disqualified. ACG this year had about 200 students, one-fourth of the available population. With the team approach apparently succeeding — ACG students earn higher GPAs than non-participants — Purdue plans to extend the competition between disciplines, and eventually, between universities.

Georgia Institute of Technology

The Office of Minority Education and Development (OMED) at Georgia Institute of Technology was an integral player in the university's decision to raise its minority graduation rate above the long-standing 50 percent level. In existence since the early 1970s, OMED is now a fully institutionalized MEP. A unique attribute of OMED is that it is headed by staff with strong engineering backgrounds. Transformed as part of a Total Quality Management exercise, the program now focuses on the student and the students' parents as its customers, and on institutional change in response to customer needs.

To better serve this customer base, OMED, the dean's office and the engineering and science faculty initiated a study of institutional barriers to student retention, uncovering an extremely strong correlation between graduation rate and first quarter GPA. Analyzing data for a ten-year period, researchers examined five-year graduation and first-quarter grade point average finding the higher the first-quarter GPA, the more likely a student was to graduate. Students with a first-quarter GPA between 3.0 and 4.0 had an 87 percent chance of graduating. Students with a first-quarter GPA between 2.0 and 2.99 had a 54 percent chance of graduating. Students with a first-quarter GPA of 1.0 to 1.9 had a 37 percent chance of graduating, while students falling below 1.0 had only an 18 percent chance of graduating.

For Georgia Tech faculty and OMED staff, the study shattered the commonly held belief that if students have a bad first quarter they can make it up. The data now existed to show students that this was rare.

Given the results, Georgia Tech shifted the focus of its summer bridge program from the socialization of students to the preparation of students for the academic work of the university. The school's assumption is that the student is ready academically, but needs assistance in developing goals, strategies for learning and full understanding of faculty expectations. The five-week summer program tries to give the student a realistic picture of what Georgia Tech is all about. While it is not exclusively an engineering program, it is engineering focused. Students take chemistry, physics, psychology, and English. They go through various exercises to familiarize themselves with the culture of Georgia Tech, and with the culture of Atlanta. They learn what will be expected of them by the faculty. Parents are included in the orientation process and come to campus for a weekend so that they too will have the same ideas and expectations as the students. It is the equivalent of an academic pre-season: "Learn how to play the game," Tech tells its students, "before you actually play the game."

OMED also uses the first-quarter statistics to expand the rationale it presents to students for high achievement early on: job possibilities and chances of admission to graduate school are diminished with less than a 3.0 GPA, with many companies hiring at Georgia Tech using a 3.0 GPA as a screen for interviewing. Students learn this during the summer, in preparation for the first quarter. Historically at Georgia Tech, the freshman body had a GPA of 2.7 or 2.8, with minority students at the 2.5 level. Now, students going through the program outperform all other students, earning a GPA of 3.0. According to Georgia Tech, this is not a remediation program. Students admitted are academically qualified and gain substantial advantage by learning effective strategies for success.

As a result of the new program, persistence of the minority students in the freshman class of 1992 was 99 percent. The university is now preparing to scale up a program designed for 200 minority students to serve 700 students — the entire freshman class.

at the most successful schools make it clear that institutional commitment typically results from leadership at the top. The next strides forward are the responsibility of university leaders, and will center on developing and implementing productive policies within the institution while advocating for action at both state and federal levels. This must occur if we are to change patterns of minority degree production in engineering, which have remained virtually constant since our measurement of institutional performance for the decade of the 1980s.

Examples of policy shifts at the university level include those at North Carolina A&T: a change in the reward system for faculty to recognize pedagogical innovation, advising and teaching as well as research, and in the definition of research to include pedagogical innovation. Is this policy generalizable and, more importantly, is it working in a way that removes barriers to student achievement? Advancing minority access and retention will require engaging the university leadership in a continuing dialogue around such solutions.

But can institutions alone provide this leadership? While we know what productive policies should look like, very little is known about the underlying constraints universities face when they contemplate significant change. One question our research on retention leads us to ask is whether the recruitment of large entering classes is driven by the need to capture revenues that will offset the projected attrition of subsequent years.

Moving beyond the campus, institutional leaders must bring the power of their office to the national debate on financial aid. Repeatedly, NACME research establishes lack of financial resources as a significant barrier between minority students and an engineering degree. In this study, when the effects of selectivity and private governance were statistically controlled, higher college costs predicted a lower Relative Retention Index, signaling less equity in graduation rates between minority

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Table 11.
Summary of Program Components

	Drexel University	Georgia Institute of Technology	Howard University	North Carolina A&T State University	Polytechnic University	Prairie View A&M University	Purdue University	Rensselaer Polytechnic Institute
Institutional Commitment	•	•	•	•	•	•	•	•
Strong MEP or Similar Program	•	•	•	•	•	•	•	•
Transfer Students	•	•	•	•	•	•	•	•
Corporate Involvement	•	•	•	•		•		•
Early Development	•		•	•		•	•	•
Summer Bridge	•	•		•		•		•
Freshman Focus		•		•		•	•	
Peer Relationship Focus			•				•	•
Total Quality Management	•	•						
Mentoring	•							
Leadership Development								•
Curriculum Reform	•				•	•		
NACME Scholarship Programs*		CSP	CSP/IGP	CSP/IGP	CSP/IGP/BA	CSP/IGP	CSP/IGP	CSP/IGP
Unique Elements		First quarter focus	Increased selectivity for incoming freshmen; aggressive recruitment	Increased selectivity for incoming freshmen; aggressive recruitment; re-vamped faculty		Increased selectivity for incoming freshmen; aggressive recruitment	Financial incentives	Total personal and program integration; NACME Diversity Seminars

*CSP = Corporate Scholars Program IGP = Incentive Grants Program BA = Big Apple Scholars Program

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and nonminority students. With financial aid policies at federal, state and institutional levels shifting aid toward the middle class and away from those students with the greatest need, the fact that highly selective, high cost, private institutions have the financial resources to offer satisfactory aid packages can give them a significant advantage in retention.

The tendency to use financial aid to support institutional goals other than access is evident at the Historically Black Colleges and Universities also. Two HBCUs in our interviews — consciously deciding to move away from their traditional mission to serve, in part, the developing student — are using scholarship dollars to attract better-prepared freshmen, regardless of need. This shift in strategy seriously impacts opportunities — economic and academic — for large numbers of students, as scarce resources are diverted to drive up institutional selectivity. And whether the phenomenon will become a trend among predominantly minority institutions bears watching.

With colleges and universities increasingly in competition for students and revenues, there are no facile answers to relieving economic need. Yet the data suggest that both access and retention are critically dependent upon scholarships. Whether university funded, private, or provided by national or state governments, adequate financial aid must be integral to increasing the production of minority graduates.

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NACME believes that every institution has an obligation to the students it admits. A class of minority and nonminority freshmen, meeting the same set of entrance criteria at the same institution should expect to graduate in equal proportions. We also believe that the institutions that lead the nation in providing research for industry and government should lead the nation in graduating engineers who work productively in diverse teams across racial, ethnic and gender barriers, and who draw creative strength from disparate world views. This can only happen if institutions create diverse environments on their own campuses.

By providing a comparative examination of institutional achievement in access and retention for minority students, NACME encourages universities to benchmark best practices, to set new goals for future growth, and to measure their achievements against those of their peers.

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